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U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS
WASHINGTON 25, D. C.

Letter
Circular
LC1010

June 3, 1953

PHYSICAL PROPERTIES OF CURRENTLY PRODUCED MARBLES

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INTRODUCTION

This letter circular was prepared in response to many requests from producers, consumers, engineers and architects for information on the properties of the marbles produced in the United States. A few white monumental marbles of foreign origin are also included in the survey. The domestic marbles described herein represent 25 quarries located in nine states. The foreign marbles represent quarries in Italy, North Africa and the Philippine Islands.

Geologically, marble is defined as a metamorphic, recrystallized limestone composed predominantly of crystalline grains of calcite or dolomite or both, having interlocking or mosaic structure. Commercially, marble is any crystalline rock composed predominantly of one or more of the following minerals: calcite, dolomite or serpentine, and should be capable of taking a high polish. About 85% of the samples described in this letter circular are in the class of marbles as defined from the geological standpoint, whereas the remaining 15 percent may be classed as commercial marbles.

The physical tests that were made on the domestic samples included determinations for abrasive hardness, water absorption and bulk density. Tests for compressive strength instead of abrasive hardness were made on the foreign samples.

The test procedures used in this study are described in ASTM Book of Standards, 1952, part 3, under the following designations: C97-47 for absorption and bulk specific gravity, C170-50 for compressive strength, and C241-51 for abrasion resistance.

The marble samples have been classed into one of four groups namely, A, B, C, or D.[1] The groups are defined as follows:

Group A: Consists of sound marbles which require no "sticking," [2] "waxing" or "filling," are characteristically uniform and have favorable working qualities.

Group B: Consists of marbles similar in character to the preceding group, but with somewhat less favorable working qualities. There are occasional natural faults which might require some "waxing" and "sticking."

Group C: Consists of marbles of uncertain variation in working qualities. Geological flaws, voids, veins and lines of separation are common. It is standard practice to repair these natural shortcomings by "sticking," "waxing" and "filling." The use of "liners"[3] and other forms of reinforcement are freely employed when necessary.

Group D: Consists of marbles similar to the preceding group and subject to the same method of finishing and manufacture but embracing those materials which contain a larger proportion of faults, and a maximum variation in working qualities. This group comprises many of the highly colored marbles prized for decorative qualities.

Table 1 gives the source and description of the domestic marbles and table 2 gives the results of the physical tests. Tables 3 and 4 present similar information for the foreign marble

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1/ This classification has been made by the Marble Institute of America and is generally accepted by the various purchasing agencies of the Federal Government.

2/ "Sticking," "waxing" and "filling" are methods used in the marble trade to repair and improve the appearance of the natural flaws, voids, veins, etc. present in the marble. Materials such as wax, shellac, coloring and marble dust are used for this purpose.

3/ "Liner" is usually a thin slab of stone cemented to the back of a piece of marble in order to reinforce it.

Table 1. Source and Description of Domestic Marbles

Sample No.	Source	Description [1/]
1	Gantt's Quarry, Ala.	Ivory cream, translucent, very few green markings
2	do	White and cream, translucent, bold prominent markings
3	do	White, translucent, well-distributed prominent markings
4	do	Cream, translucent, uniform clouded markings
5	do	Cream, translucent, some veining or clouding
6	do	Ivory-cream, translucent, occasional traces of color
7	Sylacauga, Ala.	White, green veining predominating
8	do	White and cream, very bold and prominent markings
9	do	White, prominent light clouds
10	do	White, light clouds
11	Batesville, Ark.	Dark gray, light gray spottings
12	do	Gray with brown tone and white spots
13	do	Red, white and gold spots, red veining
14	do	Rose, white and yellow spots
15	do	Gray with brown tone, golden spots and veins
16	Cartney, Ark.	Dark brown, abundance of small white spots
17	do	Dark brown, abundance of small white spots
18	Canon City, Colo.	Light brown to cream, some light rose (travertine)
19	do	Light brown to red (travertine)
20	do	Cream, light brown to red veining (travertine)
21	Tate, Georgia	White, profusion of blue-black veining
22	do	Gray, dark gray, wavy veins
23	do	White, gray veins and clouding
24	do	White, few gray veins and clouds
25	do	Rose to light pink, dark green and gray veining

1/ Underlined portion of the description signifies the background color of the marble.

Table 1. Source and Description of Domestic Marbles (Cont'd)

Sample No.	Source	Description
26	Cardiff, Maryland	Dark green, mottled veins and markings (serpentine)
27	do	Light green, mottled veins and markings (serpentine)
28	Carthage, Mo.	Light gray, distinct darker gray veining
29	do	Light gray, gray veins resembling clouds
30	do	Gray, without any distinct veining
31	St. Genevieve, Mo.	Rose, gray fossil markings
32	do	Light rose, numerous light and dark fossils
33	do	Gray, dark gray veinings, light brown markings
34	do	Light to dark gray, light brown veining
35	do	Gray, yellow or golden veins, fossil markings
36	do	Light gray and gold, yellow veins
37	do	Light to medium gray, many light and dark fossils
38	do	Medium brown, light and dark veining
39	Walnut Grove, Mo.	Light to medium gray, fine pencil-like markings
40	Marble, N. C.	Gray, blue-black wavy veining
41	Asbury, Tenn.	Dark pink, dark veins
42	do	Gray, slight tint of red, blue veinings
43	Blount County, Tenn.	Dark brown, white spots
44	do	Brownish red, with white veinings and markings
45	do	Variegated red and gray, white veining
46	do	Grayish pink, blue veining and white spots
47	do	Grayish red, small blue veinings
48	Grainger Co., Tenn.	Black, occasional white markings
49	Knoxville, Tenn.	Dark brown, white and red spots
50	do	Dark chocolate, pinkish-gray spots
51	do	Reddish brown, white spots
52	do	Brownish red, variegated with white markings
53	do	Deep brownish red, mixed with gray markings, white spots
54	do	Brownish red, variegated with white markings
55	do	Brownish red, mixed with gray and white markings

Table 1. Source and Description of Domestic Marbles (Cont'd.)

Sample No.	Source	Description
56	Knoxville, Tenn.	Grayish pink, mottled with white, pink, red and black
57	do	Brown, dark brown veinings, white spots
58	do	Deep brownish pink, fine dark veining
59	do	Deep rich red, small blue veining
60	do	Dark to medium grayish red, white spots
61	do	Variegated grayish-pink to red, blue veinings
62	do	Light to dark pink, small blue veinings
63	do	Medium to light pink, blue veining
64	do	Grayish pink to red, dark veins, some fossils
65	do	Light pink, dark colored veining
66	do	Grayish red, white spots
67	do	Grayish light red, white spots
68	do	Grayish red, white spots, red veining
69	do	Light pink, blue veining
70	do	Gray, slight tinge of pink, small blue veining
71	do	Grayish pink, darker veins
72	do	Grayish pink, small blue veining
73	do	Cream, yellowish-brown veins, some fossils
74	do	Grayish pink, blue veining
75	do	Pink and gray, white clouds, veins, fossils
76	do	Pink and gray, reddish veining, some fossils
77	do	Deep red to pink and gray, dark veins
78	do	Gray with slight pink, blue veinings
79	do	Gray, very close dark veings
80	do	Light gray, few dark veings
81	do	Pearl, some blue-black veining, clouds
82	do	Light and grayish pink, dark veins, shell markings
83	do	Gray, scattering of white spots
84	do	Light cream, irregular gold veining
85	do	Deep rose, dark brown spots, white and gray markings
86	do	Light to dark rose, irregular blue veining
87	do	Light brown, white and gray fossils

Table 1. Source and Description of Domestic Marbles (Cont'd.)

Sample No.	Source	Description
88	Clarendon, Vt.	White, gray clouds
89	Danby, Vt.	Gray, darker gray veining
90	do	White, gray clouds
91	do	White, gray green clouds
92	Florence, Vt.	Light gray, dark gray clouds
93	Isle La Motte, Vt.	Nearly black, gray flecks
94	Roxbury, Vt.	Dark green, white veins (serpentine)
95	Swanton, Vt.	Mahogany red, white spots
96	West Rutland, Vt.	White, faint flecks
97	do	White, faint green clouds
98	do	White, light green markings
99	do	White, light green clouds
100	do	White-cream, light green veining
101	West Rutland, Vt.	White, light green veining
102	do	Cream, faint green veining
103	do	White, narrow green stripes
104	do	White, wide green bands
105	do	White, light green mottle
106	do	Light green, occasional tan markings
107	do	Light gray, dark green veining
108	do	Green, white clouds
109	do	White, heavy green clouds
110	do	White, abundant green clouds
111	do	Gray, darker gray clouds
112	do	White, gray veining

Table 2. Results of Tests on Domestic Marbles.

Sample No.	Abrasive Hardness (H_a value) 4/	Absorption (48 hr)	Bulk Specific Gravity	Weight per cu ft	Group
		percent		lb	
1	13.8	0.11	2.71	169.2	B
2	14.2	0.14	2.70	168.5	A
3	12.7	0.13	2.70	168.5	A
4	9.2	0.14	2.70	168.5	A
5	10.6	0.14	2.70	168.5	A
6	10.3	0.14	2.70	168.5	A
7	19.5	0.11	2.71	169.2	B
8	17.9	0.10	2.71	169.2	B
9	16.0	0.08	2.71	169.2	A
10	11.4	0.09	2.71	169.2	A
11	38.5	0.14	2.69	167.9	B
12	17.6	0.34	2.68	167.3	B
13	16.6	0.19	2.65	165.4	C
14	12.7	0.23	2.67	166.7	C
15	25.6	0.27	2.68	167.9	B
16	12.8	0.43	2.66	166.0	C
17	24.0	0.22	2.68	167.3	C
18	13.2	1.10	2.47	154.0	C
19	19.8	0.75	2.52	157.3	C
20	18.4	1.58	2.46	153.5	C

4/ The H_a value is an expression of wear resistance and is the reciprocal, multiplied by 10, of the volume of material abraded in a 5 min test, using the National Bureau of Standards Abrasion Machine. The higher the H_a value, the more resistant to abrasion is the material.

Table 2. Results of Tests on Domestic Marbles,(cont'd.)

Sample No.	Abrasive Hardness 4/ (H_a value)	Absorption (48 hr)	Bulk Specific Gravity	Weight per cu ft	Group
		percent		lb	
21	17.4	0.09	2.71	169.2	A
22	15.6	0.11	2.71	169.2	A
23	15.9	0.12	2.71	169.2	A
24	16.1	0.10	2.71	169.2	A
25	13.4	0.08	2.71	169.2	A
26	55.2	1.03	2.66	166.0	C
27	43.2	1.56	2.63	164.2	C
28	16.1	0.59	2.64	164.8	A
29	19.0	0.83	2.64	164.8	A
30	16.6	0.86	2.63	164.2	A
31	16.4	0.14	2.69	167.9	C
32	14.7	0.16	2.68	167.3	C
33	15.4	0.63	2.64	164.8	C
34	17.4	0.36	2.68	167.3	C
35	19.9	0.18	2.68	167.3	C
36	18.4	0.40	2.67	166.7	C
37	16.7	0.30	2.67	166.7	C
38	19.1	0.43	2.68	167.3	C
39	17.4	0.46	2.64	164.8	A
40	19.2	0.07	2.72	169.8	A
41	23.7	0.07	2.70	168.5	A
42	21.8	0.07	2.70	168.5	A
43	24.6	0.07	2.70	168.5	A
44	30.9	0.06	2.71	169.2	A
45	28.1	0.07	2.71	169.2	C
46	24.9	0.07	2.71	169.2	A
47	23.4	0.08	2.70	168.5	A
48	37.7	0.15	2.72	169.8	B
49	27.3	0.07	2.71	169.2	A
50	26.1	0.05	2.70	168.5	A

Table 2. Results of Tests on Domestic Marbles, (cont'd.)

Sample No.	Abrasive Hardness 4/ (H_a value)	Absorption (48 hr)	Bulk Specific Gravity	Weight per cu ft	Group
		percent		lb	
51	21.9	0.07	2.70	168.5	A
52	44.3	0.06	2.71	169.2	C
53	36.6	0.02	2.71	169.2	C
54	39.2	0.01	2.71	169.2	C
55	27.3	0.05	2.71	169.2	C
56	26.7	0.05	2.71	169.2	A
57	21.0	0.09	2.70	168.5	A
58	25.6	0.04	2.71	169.2	A
59	22.5	0.05	2.70	168.5	A
60	24.7	0.07	2.70	168.5	A
61	22.8	0.08	2.70	168.5	A
62	25.0	0.06	2.70	168.5	A
63	23.0	0.05	2.70	168.5	A
64	22.0	0.07	2.70	168.5	A
65	23.6	0.09	2.70	168.5	A
66	22.7	0.01	2.70	168.5	A
67	26.9	0.05	2.71	169.2	A
68	27.7	0.06	2.70	168.5	A
69	24.8	0.06	2.70	168.5	A
70	22.4	0.07	2.70	168.5	A
71	22.7	0.08	2.70	168.5	A
72	24.4	0.07	2.70	168.5	A
73	20.6	0.09	2.70	168.5	A
74	21.3	0.10	2.70	168.5	A
75	26.4	0.05	2.70	168.5	C
76	27.7	0.11	2.69	167.9	C
77	21.6	0.06	2.70	168.5	A
78	21.8	0.10	2.70	168.5	A
79	23.4	0.09	2.70	168.5	A
80	20.4	0.11	2.69	167.9	A
81	23.2	0.10	2.69	167.9	A

Table 2. Results of Tests on Domestic Marbles, (cont'd.)

Sample No.	Abrasive Hardness 4/ (H_a value)	Absorption (48 hr)	Bulk Specific Gravity	Weight per cu ft	Group
		percent		lb	
82	21.4	0.06	2.70	168.5	A
83	27.7	0.06	2.70	168.5	A
84	24.8	0.58	2.65	165.4	C
85	28.8	0.02	2.71	169.2	C
86	26.8	0.07	2.71	169.2	C
87	28.2	0.05	2.70	168.5	A
88	13.0	0.12	2.70	168.5	A
89	9.9	0.14	2.70	168.5	A
90	10.1	0.12	2.70	168.5	A
91	10.6	0.15	2.70	168.5	A
92	12.8	0.11	2.70	168.5	A
93	24.2	0.14	2.70	168.5	A
94	77.0	0.18	2.72	169.8	C
95	34.4	0.16	2.81	175.4	C
96	7.9	0.20	2.70	168.5	A
97	7.2	0.20	2.70	168.5	A
98	8.4	0.19	2.70	168.5	A
99	9.0	0.19	2.70	168.5	A
100	9.6	0.20	2.70	168.5	A
101	7.5	0.17	2.70	168.5	A
102	11.6	0.17	2.71	169.2	A
103	10.6	0.21	2.70	168.5	A
104	10.6	0.17	2.70	168.5	A
105	9.0	0.16	2.71	169.2	A
106	8.8	0.16	2.72	169.8	A
107	8.6	0.19	2.72	169.8	A
108	9.5	0.21	2.71	169.2	A
109	8.8	0.18	2.71	169.2	A
110	7.9	0.17	2.71	169.2	A
111	8.7	0.15	2.70	168.5	A
112	11.1	0.15	2.70	168.5	A

Table 3. Source and Description of Some Foreign White Marbles

Sample No.	Source	Description
A[1/]	Carrara, Italy	White, gray veins and, or clouds
B[2/]	Merano, Italy	White, some gray veins or markings or both
C	Lago di Garda, Italy	White, gray markings
D	Phillippeville, North Africa	White, gray markings, some veins
E	Lio Deposit, Philippine Islands	White, few gray markings
F	Mindoro, Philippine Islands	White, few gray markings

1/ Eight samples from several quarries in the Carrara region were tested.

2/ Twelve samples from the Merano region were tested.

Table 4. Results of Tests on Some Foreign White Marbles.

Sample No.	Compressive Strength lb/in.^{2}	Absorption (48 hr) percent	Bulk Specific Gravity	Weight per cu ft lb	Group
A 1/	13,100 to 16,100 (Avg. = 14,500)	0.08 to .11 (Avg. = .095)	2.70 to 2.71 (Avg. = 2.71)	169.2	A
B 2/	11,200 to 13,100 (Avg. = 12,400)	0.08 to .13 (Avg. = .11	2.70 to 2.71 (Avg. = 2.705)	168.9	A
C	12,200	0.08	2.71	169.2	A
D	16,400	0.12	2.71	169.2	A
E	17,700	0.08	2.72	169.8	A
F	14,700	0.11	2.71	169.2	A

1/ Eight samples from several quarries in the Carrara region were tested.

2/ Twelve samples from several quarries in the Merano region were tested.

References

National Bureau of Standards publications relating to marble are listed below:

"Physical and Chemical Tests on the Commercial Marbles of the United States," Technologic Paper T123 (1919).

"A Study of the Problems Relating to the Maintenance of Interior Marble," Technologic Paper T349 (1926-27).

"Wear Resistance of Natural Stone Flooring," Research Paper 612, (1933).

"Stone Exposure Test Wall," Building Materials and Structures Report BMS 125, (1951).